PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F41G 9/00

A1

(11) International Publication Number: WO 00/52414

(43) International Publication Date: 8 September 2000 (08.09.00)

(21) International Application Number: PCT/US99/04708

(22) International Filing Date: 3 March 1999 (03.03.99)

(71)(72) Applicant and Inventor: LINICK, James, M. [US/US]; 7855 Vizcaya Way, Naples, FL 34108 (US).

(74) Agents: SCOTT, Thomas, J., Jr. et al.; Hunton & Williams, 1900 K Street, N.W., Washington, DC 20006 (US).

(81) Designated States: IL, JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

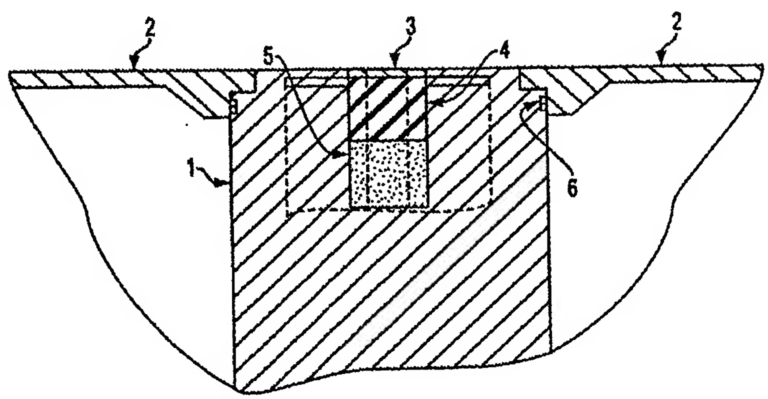
Published

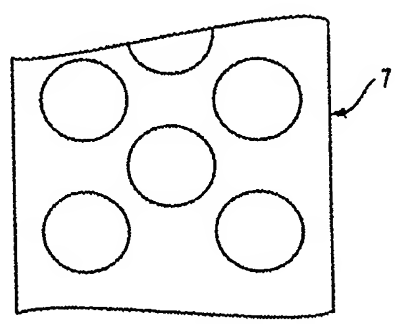
With international search report.

(54) Title: IMPULSE MOTOR TO IMPROVE TRAJECTORY CORRECTABLE MUNITIONS

(57) Abstract

An device for correcting the in–flight trajectory of a munition consists of an impulse motor assembly body (1). The slug or multiple slugs (4) and propellant(s) (5) are located within the impulse motor assembly body (1). When a trajectory correction is desired and required, the individual impulse motor propellants (5) are activated and fired, and the slug or multiple slugs (4) are propelled out of the in–flight munition at a specific time and a specific angle on or near the gravimetric center of gravity of the in–flight munition. The reactive forces created by the explosion of the(se) heavy metal slugs does, by equal and opposite reaction, create a corrective vector and thereby does cause a correction in the trajectory of the in–flight munition.





FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

IMPULSE MOTOR TO IMPROVE TRAJECTORY CORRECTABLE MUNITIONS

Field of the Invention

This invention is related to the field of munitions, and more particularly toward in-flight corrections of these munitions.

Background of the Invention

There are known methods of correcting the trajectory of in-flight munitions. One such method is described in U.S. Patent No. 5,131,602, entitled "Apparatus for Remote Guidance of Cannon-Launched Projectiles." Another method is described in U.S. Patent No. 5,647,558, entitled "Method and Apparatus for Radial Thrust Trajectory Correction of a Ballistic Projectile," issued to the present inventor.

One known method of correcting the trajectory of munitions in-flight is with aerodynamic control surfaces. However, a fairly stable platform is essential for this method, and a spinning platform would make in flight direct control via this method extremely difficult. Further, such control surfaces often have a limited effect in the thin ambient air encountered at high altitudes.

Another known method uses impulse motors or rockets, usually acting nearly through the gravimetric center of gravity of the munitions in flight. perpendicular to the longitudinal axis of such a munition(s), and angularly oriented such that the equal and opposite reaction will create the desired correction. In this instance, commonly used apparatus to achieve trajectory correction consists of an impulse motor or rocket, or a series of impulse motors or rockets that may be fired once, or more than once, to produce the desired correction to the trajectory of the munition(s), in question or at least a portion of that correction thus improving the accuracy and lethality of the munition(s).

In this method, the impulse means generally consists of a form of propellant in solid, granular, liquid or gaseous form. The propellant is converted from a more solid form to a more gaseous form, which greatly

increases it material volume. This volumetric explosion creates an equal and opposite reaction to effect the in-flight trajectory correction.

The propellant requires a particular means of operational apparatus and containment, including the appropriate nozzles, internal reactive structures and the like. Such apparatus and containment means, including all those items well known in the art, utilize valuable internal pay load volume. This volume utilization is most ideally used to contain the munitions lethality means, including submunitions and various lethal charges.

As an introduction to this field of invention, it is useful to understand some of the mathematical principles involved. In one hypothetical example, an in-flight munition, with a mass of 50 kg and traveling at a speed of 200m/s, is 5000 m from the desired target. In this example, it has been determined, by some means (via on-board INS, global positioning system, ground based active or passive radar, or some other means), that a correction of 1000m is required.

$D = 5000m$ = distance from target

$Dc = 1000m$ = correction distance

$V = 200m/s$ = velocity

$D/D_c = 0.2$ $M = 50$ kg

V_c = transverse velocity correction $= V(D_c/D) = 40m/s$

E_1 = energy to achieve trajectory correction $= V_c(M) = 2000$ Ns

E_2 = energy content of ammonium perclorate (propellant) = 2500 Ns/kg

E_1/E_2 = gravametric quantity of propellant as a function of Ns/kg= 800 g

Therefore, 800g of ammonium perclorate and fuel would need to be activated in a specified direction to correct the trajectory of the munition such to hit the desired target.

The material used for these rapidly expanding propellants for trajectory correction of in-flight munition(s) may fall into three main categories as follows:

- Gaseous expansion propellant materials of the type described in the hypothetical example above.

- Deflagration materials, which could be considered as a muted or toned down explosive, could also be used. This material can possess orders of magnitude more available energy per volumetric unit than the gaseous propellant as described in the example above. Therefore, less volume would be required within the in-flight munition(s) to effect the same reaction. However, one drawback is the size of the containment apparatus and the reactive structures and other required apparatus to support such deflagration materials, with their massive forces of expansion. Such drawbacks may very well outweigh the obvious benefits of deflagration materials.
- Detonation materials could also be used in lieu of ordinary propellants or deflagration materials. Detonation materials in fact describe explosives, and can increase the force provided exponentially, as opposed to ordinary propellants and even deflagration materials.

However, the use of deflagration and detonation materials is difficult to control and may very well destroy the munition in-flight rather than correct the trajectory of such flights.

These and other drawbacks exist.

Objects of the Invention

An object of the invention is to overcome these and other drawbacks in existing devices.

It is an object of the invention to affect the necessary munition(s) correction while in-flight, resulting in increased accuracy and utilization of a minimum of internal munitions volume.

It is another object of the invention to decrease the volume occupied by the trajectory correction means and apparatus, and subsequently increase the volume available for on board lethal cargo payload of all sorts, thereby offering increased accuracy together with substantially increased lethality.

It is another object of the invention as further described herein to utilize the vastly increased power of deflagration or detonation materials, while maintaining impulse control, without destroying the munition whose trajectory is being corrected, and without increasing the trajectory correctable munition(s) cost or complexity.

It is another object of the invention to create trajectory correctable munitions whose trajectory correction means utilize substantially less internal munitions volume than munitions corrected with ordinary propellants as described in the example in the Background of the Invention, with the result being substantially increased lethality on target with no increased cost, while still providing at least a 50% to 95% improved cost to kill ratio, and a vastly decreased logistical tail because less munitions, guns, personnel and other military equipment will be required to accomplish the same mission without the benefits provided by this invention.

It is another object of the invention to provide an in-flight trajectory correction apparatus, wherein a slug is propelled away from a munition at a desired speed and direction to correct the trajectory of the invention.

It is another object of the invention to construct the slug of a heavy metal, such as depleted uranium, and be propelled by a deflagration material or a detonation material.

Summary of the Invention

To accomplish these and other objects of the invention, improved apparatus and means for trajectory correction are disclosed.

An device for correcting the in-flight trajectory of a munition consists of an impulse motor assembly body. The slug and propellant are located within the impulse motor assembly body. In one preferred embodiment, the slug is made of a heavy metal, such as depleted uranium, while the propellant is made of a deflagration material or detonation material.

When a trajectory correction of the munition is desired, the propellant is activated and the slug is shot out of the munition. This force causes a correction in the trajectory of the munition.

Brief Description of the Drawings

Fig. 1 is a representational cut away of a munition showing the structure of the impulse motor.

Fig. 1a is a representational outer expanded view of the munition showing the impulse motor.

Fig. 2 is a block diagram of the Impulse Motor Subsystem Functions.

Detailed Description of One Preferred Embodiment

Fig. 1 illustrates one preferred embodiment of the invention. An impulse motor assembly body 1 is located within the motor housing 2 of a munition. The impulse motor assembly body 1 includes a slug 4, a slug conformal cap 3, and a propellant 5 for propelling the slug 4 outward and away from the munition. The assembly body 1 is made of a strong material with some degree of malleability, such as any number of steel alloys or titanium alloys. In one embodiment, the material used in the barrel of a firearm is used. The slug may be made of a heavy metal, and in one preferred embodiment, such slugs 4 could be depleted uranium (DU) having an exponentially greater reactive mass than the reactive mass of the expanding gas alone. The slug conformal cap 3 serves to environmentally seal the slugs 4, as well as ensure an aerodynamic and conformal exterior shape for the munition(s) body. The propellant 5 may be a compressed gas, a deflagration material, a detonation material, or some other type of material which could propel a slug 4. In one preferred embodiment, squib rings 6 are located in an annular fashion around the fore and aft flanges of the Impulse Motor Assembly and will serve to separate the fore and aft sections of the round cargo holds from the Impulse Motor Assembly, thus facilitating the ejection and distribution of the lethal cargo.

The principle of this invention then is to deploy, not just expanding gas from an orifice via an explosion, whatever the explosion or the force, but to additionally deploy heavy metal slugs 4 propelled by the expanding and/or explosive material 5. This allows such propellant material to be smaller in quantity, and, therefore, more controllable. In a preferred embodiment, the

slugs 4 are launched at an angle of 90° to the longitudinal axis of the munition, and very near the munition's gravimetric center of gravity. It can be seen that if a sufficiently heavy metal slug(s) 4 can be launched at a sufficient velocity along a desired transverse vector, then the result will be an appropriate reaction necessary to correct the trajectory of the in-flight munition(s).

The shape of the slug 4 is designed to allow the most slugs (slug mass) within the impulse motor assembly. Thus, the size, shape, and distribution pattern of the slugs 4 should be designed so as not to interfere with another, as well as allow sufficient wall material between each slug to prevent sympathetic explosions from one slug to another. While the actual design would utilize a series of minimum/maximum equations vs. available volume, the slug will probably be, for a variety of cost and machining simplicity reasons, a cylinder.

Fig. 1a illustrates an expanded plane view of the exterior surface of the Impulse Motor Assembly. An Impulse Motor Assembly body is shown with multiple impulse motors in one type of configuration. A control mechanism (not shown) connected to the impulse motor assembly bodies 1 (*i.e.*, on-board computer and associated safe/arm subassembly and possibly (though not necessarily), a receiver and antenna for the reception of ground up-link signals, etc.) controls which impulse motor assembly bodies 1 will be activated and propel a slug 4 outward. Providing multiple impulse motors within the assembly body 1 around the periphery of the munition allows for more complete control of the trajectory corrections, by allowing multiple slug(s) 4 to be propelled in the necessary direction during one or more rotations and at one or more instances in time to correct the trajectory of the in-flight munition.

Figure 2 illustrates a block diagram of the impulse motor subsystem functions. In one embodiment, a safe/arm subsystem 15 is attached to N impulse motors 11-N. The safe/arm subsystem 15 is controlled by a central round CPU 16 through a primary central power supply 17. A ground computer and up-link 19 sends a signal to an antenna/receiver 18. An on-board GPS (Global Positioning System) antenna and receiver 20, and/or an on-board INS (IMU) 21, or an uplink signal from the ground computer 19 direct the primary

central CPU 16 to fire the appropriate impulse motor(s) 11-N. The on-board INS (IMU) may be preprogrammed on the ground.

Using this preferred embodiment in the first example, an in-flight munition could have the capability to launch 12 or more DU slugs, each with, for example, a diameter and length of 2.5 cm.

The mass of each slug = 236 gm 236 (12 slugs) = 2.84 kg

50 kg (mass of original munitions) /2.84 kg (mass of 12 slugs of DU) = 17.6

17.6 (original lateral velocity required to effect correction desired = 40 m/s) = 704 m/s slug velocity

A lower slug(s) velocity will produce less correction, unless the correction is done at a proportionately greater range from impact. However, increased slug mass and/or slug quantity can produce the same correction even though the slug launch velocity is decreased.

DU slugs, sub-munitions and pellets, and other DU shrapnel materials and the like are often launched at velocities approaching 2000 m/s or greater. Velocities in the hundreds of meters per second are simply accomplished and completely practical. The required deflagration or detonation materials necessary to launch such slugs at these speeds are well known in the art of weapon construction, particularly devices that explosively launch slugs of heavy metal.

The embodiment above could, for example, be used as the trajectory correction means for 155 mm cannon launched projectile munitions. With this invention, for instance, a trajectory correctable 155 mm round could carry two sidarm submunitions, or, alternatively, almost double the quantity of bomblets, rather than only one such sidearm submunition or less bomblets than when using an ordinary means of trajectory correction.

The foregoing is not intended to limit the scope of the invention, but to merely illustrate some of the preferred embodiments of the invention. The invention is only limited by the claims attached hereto.

What is Claimed is:

1. A munition with an apparatus to correct the munition trajectory in-flight, the apparatus comprising:

a device for propelling a mass away from the munition in a predetermined direction at a predetermined velocity.

2. The munition of claim 1, wherein the device comprises an impulse motor assembly, with at least one impulse motor incorporated within the body of the impulse motor assembly.

3. The munition of claim 1, wherein the device comprises a propellant which is activated to propel the mass.

4. The munition of claim 3, wherein the propellant is a deflagration material.

5. The munition of claim 3, wherein the propellant is a detonation material.

6. The munition of claim 3, wherein the propellant is a compressed gas.

7. The munition of claim 3, wherein the mass of the slug and its respective propellant gas have an exponentially greater reactive mass than the propellant alone.

8. The munition of claim 1, wherein the mass is a slug fired and thus launched according to a prescribed pattern.

9. The munition of claim 6, wherein the slug is made of a heavy metal.

10. The munition of claim 7, wherein the heavy metal is one the group comprising depleted uranium and tungsten.

11. A munition with an apparatus to correct the munition trajectory in-flight, the apparatus comprising:

a device for propelling a plurality of masses away from the munition in a predetermined direction at a predetermined velocity;

the device including an impulse motor assembly, with a plurality of impulse motors radially incorporated within the body of the impulse motor assembly.

12. The munition of claim 11, wherein each of the plurality of impulse motors includes propellant which is activated to propel the plurality of masses.

13. The munition of claim 12, wherein the plurality of masses are made of a heavy metal.

14. The munition of claim 11, wherein each of the plurality of masses is a slug; and

the plurality of slugs are launched according to a prescribed pattern.

15. The munition of claim 14, wherein each of the slugs is made of a heavy metal, and wherein the heavy metal is one the group comprising depleted uranium and tungsten.

16. The munition of claim 14, wherein the mass of the slugs and their respective propellant gases have an exponentially greater reactive mass than the propellant alone.

17. A munition with an apparatus to correct the munition trajectory in-flight, the apparatus comprising:

a device for propelling a plurality of masses away from the munition in a predetermined direction at a predetermined velocity;

wherein the device includes an impulse motor assembly, with a plurality of impulse motors radially incorporated within the body of the impulse motor assembly

each of the plurality of impulse motors includes propellant which is activated to propel each of the plurality of masses;

each of the plurality of masses is a slug; and

the plurality of slugs are launched according to a prescribed pattern.

18. The munition of claim 17, wherein the plurality of masses are made of a heavy metal, wherein the heavy metal is one the group comprising depleted uranium and tungsten.

19. The munition of claim 17, wherein the mass of the slugs and their respective propellant gases have an exponentially greater reactive mass than the propellant alone.

20. The munition of claim 17, wherein the propellant is one the group comprising a deflagration material, a detonation material, and a compressed gas.

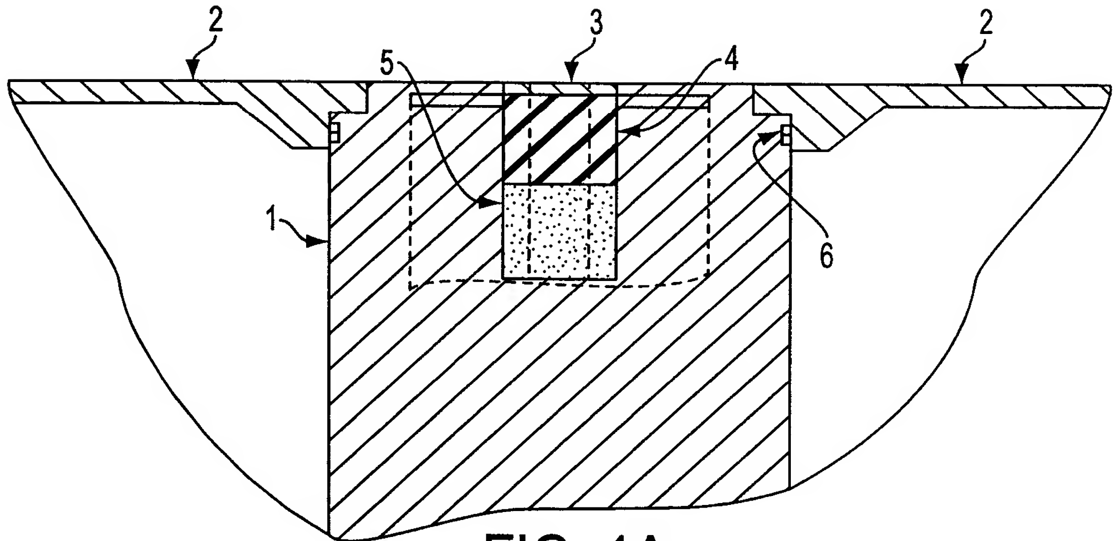


FIG. 1A

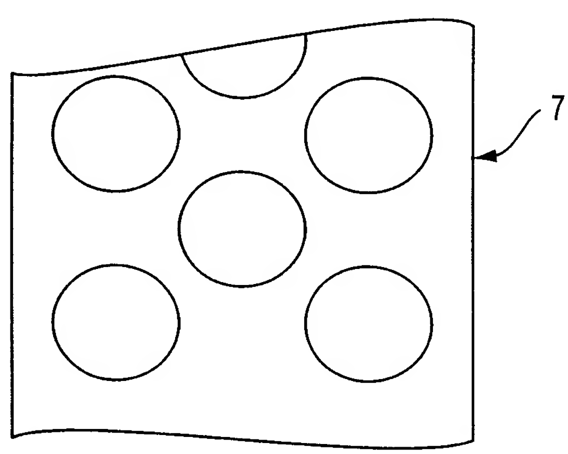


FIG. 1B

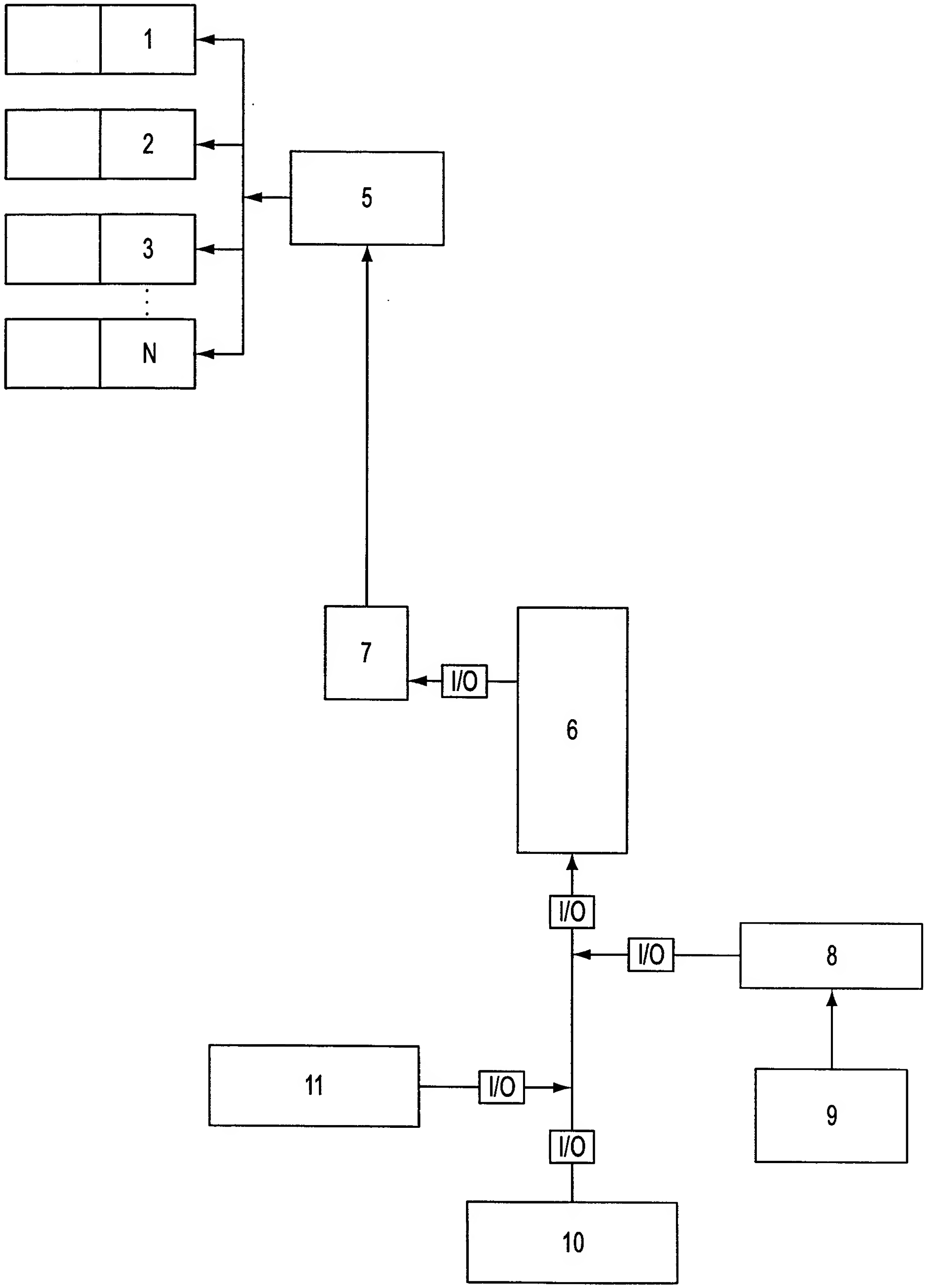


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/04708

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :F41G 9/00
US CL :244/3.21
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 102/384, 476;
244/3.1, 3.11, 3.21, 3.22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 3,860,199 A (DUNNE) 14 January 1975 (14/01/75), see Figure 6 and lines 18-55 of col. 7.	1-5, 7-9, 11-14, 17, 19, 20 6, 10, 15, 18
X Y	US 3,398,916 A (VAN VYVE) 27 August 1968 (27/08/68), see entire document.	1-3, 7, 8 4-6, 9, 10
Y	US 5,078,117 A (COVER) 07 January 1992 (07/01/92), see Figures 1-8 and the Abstract.	6
A	US 4,928,906 A (STURN) 29 May 1990 (29/05/90).	

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 OCTOBER 1999	06 DEC 1999

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
Diane Gorsline for
HAROLD TUDOR
Telephone No. (703) 306-4172

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/04708

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2,149,066 A (SCHILLING ET AL) 05 June 1985 (05/06/85)	